Efficacy of inert dusts against lesser grain borer, *Rhizopertha dominica* Fab. in stored Wheat

Jhumar Lal, K.C. Sharma and O.P. Ameta

Department of Entomology, Rajasthan College of Agriculture,
Maharana Pratap University of Agriculture and Technology, Udaipur – 313 001, India
<jhumarleelawat@gmail.com>

Date of Receipt: 11.05.2015; Accepted: 20.06.2015

ABSTRACT

A laboratory experiment was conducted to assess the efficacy of four inert dusts namely fly ash, rice husk ash, cow-dung ash and diatomaceous earth against the lesser grain borer, *Rhizopertha dominica* in stored wheat. Among the different treatment of inert dusts were evaluated by treating 100 g of wheat grains with two application rates of 0.5 and 1.0 % of grain weight against *R. dominica* up to 120 days. The grains treated by diatomaceous earth @ 1.0 % was found to be most effective with significantly (P=0.05) highest adult mortality (99.5%), least grain damage (0.25%), least weight loss (0.13%) and least population build up (0.75 adults). The least effective treatments were observed in wheat treated with fly ash and cow dung ash @ 0.5% with adult mortality (70.3 & 72.8%), population build up (17.92 & 16.75 adults), grain damage (6.4 & 5.7%) and weight loss (7.9 & 6.9%), respectively. No adverse effect of fly ash, rice husk ash, cow dung ash and diatomaceous earth were observed on the germination of treated wheat grains stored for 120 days of treatment.

Key words: Inert dusts, *Rhizopertha dominica*, *Triticum aestivum.*

In India, wheat is the second most important cereal crop after rice and it contributes nearly 25 % to the national food basket. The presence of insects in stored products has always posed unique problems. The average loss of food grains in storage due to biotic and abiotic factors accounts for 10% per year, out of which insects are contributing about 2.5 to 5.0%. Kumawat (2007) reported during survey of insect pests on stored wheat observed *R. dominica* up to 43.1% samples.

Inert dusts have low mammalian toxicity, are stable on the grain and provide protection as long as the dusts remain dry. Unlike organophosphate grain protectants, they do not leave toxic residues. Grain treated with inert dusts can be cleaned prior to milling to remove most of the dust particles. The most widely accepted explanation for the action of inert dusts is that they kill arthropods by removing or absorbing the epicuticular lipid layers causing excessive water loss through the cuticle. Thus, there is a need to develop pest control strategies which will be commercial and safer in small and large scale storage. These strategies could be achieved by exploiting the plants of medicinal and insecticidal value, which are also easily available to the farmers. The use of inert dusts is considered to be the novel approach, though they are good age old practice. Keeping the above facts in view, investigation was carried out.

Materials and Methods

The population of *R. dominica* adults used in the experiments were collected from RCA Farm, Udaipur and kept in the laboratory (at Post Harvest Biology Laboratory, Post Harvest Technology Scheme, CTE, MPUAT, Udaipur). The stock culture of the lesser grain borer was reared in laboratory in glass jars of 2 kg capacity containing the grains of wheat variety Raj-3077. Inert dusts *viz*., fly ash, rice husk ash (plant source), cow-dung ash (animal source) and diatomaceous earth were evaluated by treating 100 g of wheat grains with two application rates of 0.5 and 1.0% of grain weight, replicated three times. Untreated check was also used for comparison. Twenty five pairs of lesser grain borer adult were released in each jar, covered with muslin cloth and secured by rim of lid to disallow the entry or exit of test insect. The numbers of dead insects in each jar were counted up to 120 days at an interval of 30, 60, 90 and 120 days. The observation on population build up was recorded by sieving the grains and counting the total number of adult beetles at monthly intervals. Before estimating the damaged grains, they were thoroughly mixed and samples of 100 grains were drawn for five times from each bottle, then damage grains in 100 seeds were counted for each sample. The observation on % weight loss was recorded by counting number of un-infested grains and number of infested grains. Weight loss was worked out by using the following formula.

where U = Weight of uninfested seeds (g)

$$\% \text{ weight loss} = \frac{(UND) - (DNU)}{U\ (ND + NU)} \times 100$$

NU = Number of uninfested seeds

D = Weight of infested seeds (g)

ND = Number of infested seeds

The effect of inert dusts was studied on germination of wheat grains at 0, 30, 60, 90 and 120 days of treatment. The data recorded were subjected to statistical analysis.

Results and Discussion

The data revealed that adult mortality ranged from 80.0 to 100.0% in grains treated with different inert dusts after 30 days of storage (Table 1). The cent per cent mortality of adult beetles was observed in diatomaceous earth and rice husk ash at 0.5 and 1.0%. Minimum adult mortality of 80.0% was recorded in grains treated with fly ash at 0.5%, it was at par with fly ash at 1.0% and cow dung ash at 0.5% with 81.7 and 83.3% respectively. After 60 days of storage, the adult mortality ranged from 76.0 to 100.0% in grains treated with different inert dusts. The cent per cent adult mortality was observed in diatomaceous earth at 0.5 and 1.0% and rice husk ash at 1.0% followed by rice husk ash at 0.5% with 91.6%. The adult mortality ranged from 73.3 to 99.0% in grains treated with different inert dusts after 90 days of storage. The maximum (100 & 99.0%) adult mortality was observed in grains treated with diatomaceous earth at 1.0 and 0.5%, respectively followed by rice husk ash at 1.0% (95.0%) and 0.5% (90.0%). At 120 days after storage, the adult mortality ranged from 73.3 to 99.0% in grains treated with different inert dusts. Similar results were reported by Sharma and Bajracharya (2006). The significantly maximum 98.0 and 97.0% adult mortality was observed in grains treated with diatomaceous earth at 1.0 and 0.5%, respectively. Minimum (65.3%) adult mortality was recorded in grains treated with cow dung ash at 0.5% which was at par with fly ash at 0.5% with 71.6%. All the inert dusts were found most effective in causing mortality as compared to control. These findings are in agreement with the findings of Waqas *et al*. (2006), who found that diatomaceous earth @ 500 and 600 ppm were highly effective resulting in 100% adult mortality of *R. dominica* in three weeks of exposure interval to treated wheat. The present investigation are also in agreement with the finding of Manjunath *et al.* (2014).

Population build up ranged from 0.0 to 13.0 adult beetles in grains treated with different inert dusts after 30 day of storage. The population build up were higher in grains treated with fly ash at 0.5% (13.00 adults) and cow dung ash at 0.5% (9.67 adults). No population build up were recorded in grains treated with diatomaceous earth at 0.5 and 1.0% and rice husk ash at 1.0%. While, fly ash at 1.0% was found at par with cow dung ash at 1.0%. At 60 day after storage the population build up ranged from 0.00 to 17.33 adult beetles in grains treated with different inert dusts. No population build up was observed in grains treated with diatomaceous earth at 0.5 and

Table 1. Effect of different inert dusts on mortality and progeny development of lesser grain borer.

Inert dust	Dose (%)	Mortality (%)					Progeny development (No. of adults)				
		30 DAS	60 DAS	90 DAS	120 DAS	Mean	30 DAS	60 DAS	90 DAS	120 DAS	Mean
Fly ash	0.5	80.0^{d} (63.48)	76.0^{d} (60.71)	73.3^{e} (58.92)	71.7^{g} (57.87)	75.25^{g}* (60.25)	13.00^{f} (3.67)	16.00^{e} (4.06)	19.67^{h} (4.49)	23.00^{h} (4.84)	17.92^{g}** (4.27)
Fly ash	1.0	81.6^{cd} (64.74)	86.7^{c} (61.14)	76.7^{d} (54.74)	76.7^{f} (61.13)	80.42^{e} (60.44)	8.00^{c} (2.92)	10.00^{c} (3.23)	14.00^{f} (3.89)	20.00^{f} (4.52)	13.00^{e} (3.64)
Rice husk ash	0.5	100.0^{a} (90.00)	91.7^{b} (73.51)	90.0^{cd} (71.76)	79.7^{ef} (63.24)	90.34^{c} (74.63)	1.33^{b} (1.34)	1.00^{b} (1.22)	4.00^{d} (2.11)	9.00^{d} (3.08)	3.83^{c} (1.94)
Rice husk ash	1.0	100.0^{a} (90.00)	100.0^{a} (90.00)	95.0^{b} (77.14)	86.7^{cd} (68.76)	95.42^{b} (81.48)	0.00^{a} (0.71)	0.00^{a} (0.71)	1.33^{b} (1.34)	6.33^{c} (2.61)	1.92^{b} (1.34)
Cow dung ash	0.5	83.3^{c} (66.07)	86.7^{c} (68.84)	68.3^{f} (55.78)	65.3^{h} (53.95)	75.92^{fg} (61.16)	9.67^{e} (3.19)	17.33^{d} (4.22)	19.00^{g} (4.41)	21.00^{g} 95.00^{b}	16.75^{f} (4.11)
Cow dung ash	1.0	90.0^{b} (71.74)	86.7^{c} (68.70)	76.7^{d} (61.15)	83.3^{de} (65.98)	84.17^{de} (66.84)	8.33^{d} (2.97)	10.00^{c} (3.24)	12.33^{e} (3.58)	18.33^{e} (4.34)	12.25^{d} (3.53)
Diatomaceous earth	0.5	100.0^{a} (90.00)	100.0^{a} (90.00)	99.0^{a} (84.66)	97.0^{b} (80.21)	99.00^{a} (86.22)	0.00^{a} (0.71)	0.00^{a} (0.71)	2.00^{c} (1.56)	5.33^{b} (2.41)	1.83^{b} (1.35)
Diatomaceous earth	1.0	100.0^{a} (90.00)	100.0^{a} (90.00)	100.0^{a} (90.00)	98.0^{a} (82.14)	99.50^{a} (88.04)	0.00^{a} (0.71)	0.00^{a} (0.71)	0.00^{a} (0.71)	3.00^{a} (1.81)	0.75^{a} (0.99)
Control	–	6.0^{e} (14.05)	4.3^{e} (11.94)	4.0^{g} (11.48)	3.7^{g} (10.86)	4.5^{h} (12.08)	30.00^{g} (5.52)	43.00^{f} (6.60)	53.00^{i} (7.31)	66.00^{i} (8.15)	48.00^{h} (6.90)
SEm±		1.32	1.47	1.17	1.48	1.36	1.48	1.36	0.06	0.07	0.09
CD (P=0.05)		3.92	4.37	3.47	4.40	4.04	4.40	4.04	0.19	0.22	0.28

*Figures in parentheses are angular retransformed values, ** Figures in parentheses are square root retransformed values; DAS- Days after storage, In a column means followed by the same letter do not differ significantly by DMRT (P = 0.05).

Table 2. Effect of different inert dusts on grain damage and weight loss caused by lesser grain borer.

Inert dust	Dose (%)	Grain damage (%)					Weight loss (%)				
		30 DAS	60 DAS	90 DAS	120 DAS	Mean	30 DAS	60 DAS	90 DAS	120 DAS	Mean
Fly ash	0.5	3.3^{d} (10.52)	4.8^{d} (12.74)	7.1^{gh} (15.49)	10.4^{g} (18.88)	6.45^{g} (14.41)*	3.6^{e} (10.97)	6.6^{f} (14.95)	10.0^{h} (18.46)	11.9^{h} (20.18)	7.92^{e} (15.99)*
Fly ash	1.0	2.5^{c} (9.16)	3.2^{bc} (10.41)	6.3^{fg} (14.57)	9.0^{e} (17.45)	5.28^{ef} (12.90)	2.1^{cd} (8.47)	4.4^{d} (12.11)	7.8^{f} (16.25)	9.6^{f} (18.08)	6.01^{d} (13.72)
Rice husk ash	0.5	1.0^{b} (5.74)	3.2^{b} (10.30)	4.4^{d} (12.19)	6.8^{d} (15.11)	3.87^{d} (10.84)	1.4^{bc} (6.99)	2.0^{c} (8.13)	3.4^{d} (10.62)	4.8^{d} (12.65)	2.92^{c} (9.58)
Rice husk ash	1.0	0.0^{a} (0.00)	0.0^{a} (0.00)	3.0^{c} (10.06)	5.9^{c} (14.10)	2.25^{c} (6.04)	0.0^{a} (0.00)	0.0^{a} (0.00)	2.4^{c} (9.02)	3.5^{c} (10.84)	1.54^{b} (4.97)
Cow dung ash	0.5	3.2^{cd} (10.40)	3.5^{bc} (10.83)	6.6^{g} (14.88)	9.6^{f} (18.11)	5.77^{f} (13.56)	3.0^{de} (9.97)	5.7^{e} (13.81)	8.6^{g} (17.10)	10.2^{g} (18.67)	6.91^{d} (14.89)
Cow dung ash	1.0	2.7^{cd} (9.51)	3.2^{b} (10.30)	5.8^{ef} (13.93)	9.3^{ef} (17.79)	5.27^{e} (12.88)	1.0^{ab} (5.74)	1.2^{b} (6.31)	4.7^{e} (12.58)	7.5^{e} (15.91)	3.62 ^{c} (13.86)
Diatomaceous earth	0.5	0.0^{a} (0.00)	0.0^{a} (0.00)	1.3^{b} (6.63)	3.2^{b} (10.30)	1.13^{b} (4.23)	0.0^{a} (0.00)	0.0^{a} (0.00)	1.4^{b} (6.81)	2.0^{b} (8.12)	0.85^{ab} (3.73)
Diatomaceous earth	1.0	0.0^{a} (0.00)	0.0^{a} (0.00)	0.0^{a} (0.00)	1.0^{a} (5.74)	0.25^{a} (1.44)	0.0^{a} (0.00)	0.0^{a} (0.00)	0.0^{a} (0.00)	0.5^{a} (4.12)	0.13^{a} (1.03)
Control	–	13.8e (21.86)	17.4^{e} (24.65)	25.6^{i} (30.39)	37.0^{h} (37.46)	23.47^{h} (28.59)	7.5^{f} (15.24)	13.8^{g} (21.18)	20.0^{i} (26.58)	26.1^{h} (30.77)	15.75^{f} (22.59)
SEm±		0.25	0.29	0.20	0.15	0.27	0.36	0.25	0.08	0.19	0.33
CD (P=0.05)		0.74	0.86	0.60	0.46	0.79	1.08	0.73	0.25	0.55	0.97

* Figures in parentheses are angular retransformed values, DAS- Days after storage; In a column means followed by the same letter do not differ significantly by DMRT (P = 0.05).

Table 3. Effect of different inert dusts on the germination of wheat grains.

Inert dust (%)	Mean germination		
	0 DAS	30 DAS	60 DAS
Fly ash (0.5)	91.3 (72.95)	90.3 (71.90)	87.6 (69.53)
Fly ash (1.0)	93.0 (74.73)	91.0 (72.73)	89.0 (70.69)
Rice husk ash (0.5)	90.0 (71.58)	89.6 (71.38)	83.3 (66.18)
Rice husk ash (1.0)	94.0 (75.95)	92.6 (74.45)	89.0 (70.69)
Cow dung ash (0.5)	89.0 (70.95)	86.3 (68.34)	88.6 (70.50)
Cow dung ash (1.0)	94.3 (76.27)	93.6 (75.84)	91.0 (72.87)
Diatomaceous earth (0.5)	93.3 (75.22)	93.0 (75.06)	91.6 (73.49)
Diatomaceous earth (1.0)	94.0 (75.95)	94.0 (76.35)	93.0 (74.73)
Control	91.6 (73.26)	90.0 (71.67)	87.3 (69.27)
SEm±	1.45	1.95	1.93
CD (P=0.05)	NS	NS	NS

*Figures in parentheses are angular retrans formed values, DAS- Days after storage, NS – Non significant.

1.0% and rice husk ash at 1.0%, similar results were reported by Manjunatha *et al*. (2014). The maximum (17.33 adults) population build up was observed in grains treated with cow dung ash at 0.5 % and was found at par with fly ash at 0.5% with (16.00 adults). At 90 day after storage, the population build up ranged from 0.00 to 19.67 adult beetles in grains treated with different inert dusts. No population build up was recorded in grains treated with diatomaceous earth at 1.0%. The maximum (19.67 adults) population build up were observed in grains treated with fly ash at 0.5% which was found at par with cow dung ash at 0.5% (19.00 adults). At 120 day after storage, the population build up ranged from 3.00 to 23.00 adult beetles. The minimum (3.00 adults) population build up was recorded in grains treated with diatomaceous earth at 1.0% followed by diatomaceous earth at 0.5% (5.33 adults) which was at par with rice husk ash at 1.0% (6.33 adults). Upadhyay and Srivastava (2010) attributed the development and mortality of *R. dominica* to resistance trait of wheat grain. The maximum (23.00 adults) population build up was observed in grains treated with fly ash at 0.5 % which was at par with fly ash at 1.0 % (20.00 adults) and cow dung ash at 0.5 % (21.00 adults). Boomathi *et al.* (2006) reported cow exereta and urine were found effective however wheat applied with cow exereta with NSKE resulted significant control of insect pests.

The grains treated with rice husk ash at 1.0%, diatomaceous earth at 0.5 and 1.0% were found free from grain damage. While, maximum (3.3%) grain damage was observed in grains treated with fly ash at 0.5%. It was found at par with cow dung ash at 0.5% (3.2%). At 60 days of storage the grain damage followed the same trend as reported above Ravi *et al.* (2006) utilized organic manures like FYM, biogas slurry and vermicompost singly found effective against sucking insect pests in field. After 90 days of storage, the grain damage ranged from 0.00 to 7.13% in grains treated with different inert dusts, however diatomaceous earth at 1.0% was free from grain damage followed by diatomaceous earth at 0.5% (1.33). Insect damage of *R. dominica* on wheat was attributed to the grain hardness as demonstrated by Mensah and Okonkwo (2000). The results of the present investigation corroborates with the study conducted by Manjunatha *et al.*(2014). Singh (1997) found that low ovipositional behaviour and development of three bruchids due to high or low temperatures in outdoor conditions.

The data revealed that grain weight loss ranged from 0.0 to 3.6% in grains treated with different inert dusts after 30 days of storage. Maximum (3.6%) weight loss was recorded in grains treated with fly ash at 0.5% followed by cow dung ash at 0.5% (3.0%). Whereas, no weight loss were recorded in grains treated with diatomaceous earth at 0.5 and 1.0% and rice husk ash at 1.0%. The weight loss ranged from 0.0 to 6.6% in grains treated with different inert dusts after 60 days of storage. Maximum weight loss was recorded in grains treated with fly ash at 0.5% (6.6%) and cow dung ash at 0.5% (5.7%). Whereas, no weight loss were recorded in grains treated with diatomaceous earth at 0.5 and 1.0% and rice husk ash at 1.0%. At 90 days after storage the weight loss followed the same trend on the results on stored wheat.

The results on germination revealed that no adverse effect of fly ash, rice husk ash, cow dung ash and diatomaceous earth were observed up to 60 days of treatment (Table 3). No adverse effect of fly ash on the germination of wheat grains was observed by Kumar and Gupta (2008), also reported that no adverse effect of fly ash on the nutritional quality and % germination of pea**.** Similar results on germination and growth of legumes by application of fly ash in soil was observed by Trivedi *et al.* (2007).

References

Boomathi, N., P. Sivasubramanian, and S. Reguraman (2006). Biological activities of cow excreta with NSKE against *Helicoverpa armigera*. *Ann. Pl. Protec. Sci.* **14**: 11-16.

Kumar, Vipin and Pramila Gupta (2008). Efficacy of fly ash based *Rhizobium* on growth and incidence of powdery mildew in pea. *Ann. Pl. Protec. Sci.* **16**: 248-149.

Kumawat, K.C. (2007). Effect of abiotic factors on biology of *Rhizopertha dominica* on wheat. *Ann. Pl. Protec. Sci.* **15**: 111-115.

Manjunatha, Rana, H., Hemant Lyall and Ramesh Naik N. (2014). Control of *Callosobruchus chinensis* stored chick pea. *Ann. Pl. Protec. Sci.* **22**: 435-437.

Mensah, G.W.K. and C.A.C. Okonkwo (2000). Evaluation of selected sorghum cultivars for post harvest susceptibility to the lesser grain borer, *Rhizopertha dominica. Ann. Pl. Protec. Sci.* **8**: 1-7.

Ravi, M., N. Dhandapani, N. Sathiah and M. Murugan (2006). Influence of organic manures and fertilizers on incidence of sucking pests of sunflower. *Ann. Pl. Protec. Sci.* **14**: 41-44.

Sharma, R.K. and A.S.R. Bajracharya (2006). Measuring susceptibility in maize varieties in free and no choice tests against *Sitophilus oryzae* and *Rhizopertha dominica. Ann. Pl. Protec. Sci.* **14**: 357-361.

Singh, S. (1997). Ovipositional behaviour and development of three species of bruchids under field conditions. *Ann. Pl. Protec. Sci.* **5**: 214-215.

Trivedi, Shobha, S.N. Gurha and Parual Shukla (2007). Anagonistics fungi as seed dresses in management of chick pea. *Ann. Pl. Protec. Sci.* **15**: 515-516.

Upadhyaya, Meenakhhi and A.K. Srivastava (2010). Response of wheat varieties to lesser grain borer, *Rhizopertha dominica. Ann. Pl. Protec. Sci.* **18**: 144-147.

Waqas, W., A. Muhammad, S. Arzoo, J. Amer and S. Muhammad (2006). Efficacy of diatomaceous earth (protect-it) as a protectant of stored wheat against *Rhizopertha dominica* (F.) (Coleoptera: Bostrychidae), *Pakistan Entomologist*, **28**: 2.